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Effect of interaction between thermal radiation and seasonal variation on some physical properties of selected cassava cultivars(esculentacrantz) in the niger delta nigeria.

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Abstract: *The effect of interaction between thermal radiation and seasonal variation on some physical properties of selected cassava cultivars in the Niger Delta Nigeria was studied. The study was carried out around Emuoha Local government Area of River State for a period of twelve (12) months from July to June. Three exotic cassava cultivars (coded TMS-30572; NR-8082 and NR-84292) were planted and monitored at various distances from thermal radiation source (flare site): 0-150m; 150-300m; 300-450m; 450-600m and 1000-2000m. The results showed that there were significant effects of thermal radiation on leaf area (0.561**) at 0- 600m (448.91±5.37d w/m^2,) but the effect was not significant (0.132) at 1000-2000m (428.83±0.79ew/m^2).Similar trends were observed with other physical parameters except for plant height and number of leaves. Results of seasonal variation showed favourable values for physical parameters at early dry and late wet seasons for all three cassava cultivars. However, NR-8082 and TMS-30572 show high degree of resistance to heat and other environmental stress while NR 84292 exhibited less resistance to radiation effect. The effect of season was significant (P<0.001). For NR-84292, early wet 117.9 ± 6.71 $cm^{2,}$ late wet 192.59 ± 14.17 cm^2, the values for early dry and late dry were 183.54 ± 10.00 cm^2 and 121.17 ± 5.05 cm^2 respectively. TMS-30572 showed high response to seasonal variations. Early dry 219.63 ± 6.93 cm^2 and late dry 153.73 ± 3.33 cm^2.The disease index was severe (DI=3.1 ± 0.2) at late dry season with NR-8082 and less with NR-84292 and TMS-30572 (DI=0.7 ± 0.2) at late wet season the effect was significant (P<0.001).Further work that could allay the fears of the rural communities as well as guarantee cassava tolerance potential has been suggested.*

Keywords: *cassava, cultivars, thermal radiation, seasonal variation, physical properties, flare.*

I. Introduction

The Nigeria Niger Delta environment is regarded as the vast reservoir of crude oil and gas resources, from where man draws to sustain his economic activities and to ensure his survival. [1]

The environment of Niger Delta is degrading, deteriorating and being destroyed by pollution resulting from oil and gas exploration, exploitation and production. This fragile environment is being polluted by the introduction into it of substances and energy that are liable to cause hazards to human health, harmful to living organisms, resources, agricultural activities and production and ecological systems as well as interference with legitimate uses of the environment

Indeed man's activities lead to oil spillage, air pollution, land pollution, water pollution, thermal pollution and noise pollution.

Thermal pollution results from the use of fire (burning) directly on the environment. In the Niger Delta, gas flaring is the major source of thermal pollution. This goes on for 24 hours every day, for more than three decades.

Gas flaring is the burning of natural gas that is associated with crude oil when it is pumped up from the ground. In petroleum-producing areas where insufficient investment was made in infrastructure to utilize natural gas, flaring is employed to dispose of this associated gas[2]. Also chemical factories, oil refineries, oil wells, rigs and landfills, gaseous waste products and sometimes even non-waste gases produced are routed to an elevated vertical chimney called a gas flare and burnt off at its tip. This is called gas flaring. Waste gases are subjected to such a process either because the gases are waste or it is difficult to store and transport them. Non-waste gases are burnt off to protect the processing equipment when unexpected high pressure develops within them. Gas flaring in oil rigs and wells contribute significantly to greenhouse gases in our atmosphere[3].

Flaring and venting of associated natural gas are widely used in the petroleum industry to dispose of associated natural gases for safety reasons during petroleum development operations and/or where no infrastructure exists to bring it to market [4].

The flares associated with gas flaring give rise to atmospheric contaminants. These include oxides of Nitrogen, Carbon and Sulphur (NO_2, CO_2, CO, SO_2), particulate matter, hydrocarbons and ash, photochemical oxidants, and hydrogen sulphide[5a] and[5b]. These contaminants acidify the soil, hence depleting soil nutrient. Previous studies have shown that the nutritional value of crops within such vicinity are reduced[6].

The effects of the changes in temperature on crops included stunted growth, scotched plants and such other effects as withered young crops [7].

Miller [8], reported that thermal radiation over the years are known to cause growth reduction, defined as reduction in the growth of the organism as well as reduced seed germination, abnormalities, or reduction in viability of offspring's. According to Ryan[9], thermal radiation resulted in direct burn damage to exposed tissue.

This work assessed the effect of interaction between thermal radiation and seasonal variation on some physical properties of selected cassava cultivars in the Niger Delta Nigeria.

II. Experimental

2.1 Location of experimental site:

The experimental plots were sited on an agro-ecological zone. The coastal plain sands of Emuoha Local Government Area of River state hosting flow station of a multinational oil exploration company was selected.
Emuoha is a humid tropical area. The rainfall pattern is bimodal with peaks in June and September, and the period of low precipitation in August. The long rainy season is between April and early August, while the short rainy season is between late August and October. The dry season is from November to March interrupted occasionally by sporadic down pour. Emuoha has an annual rainfall of between 2000mm and 2453mm, while the annual temperature is between 22.6^0C and 31.2^0C Rivers State Agricultural Development Programme[10]. The experiment was conducted for a period of 12 months: starting from July to June using the seasonal variations shown in Table 2.1

Table. 2.1: Seasonal variations

SEASONS	MONTHS		
LATE WET	JULY	AUGUST	SEPTEMBER
EARLY DRY	OCTOBER	NOVEMBER	DECEMBER
LATE DRY	JANUARY	FEBRUARY	MARCH.
EARLY WET	APRIL	MAY	JUNE

2.2 Cultivars:

Three exotic cultivars obtained from the National Root Crop Research Institute (NRCRI) UmudikeUmuahia, Abia state were used for the experiment. These were:
TMS – 30572
NR – 8082
NR – 84292

2.3 Experimental design:

Randomised complete block design (RCBD) with three (3) treatments in five replications were used [11].The plots were designed according to distance: 0-150m, 150-300m, 300-450m, 450-600m and 1000-2000m. All the experimental plots were in the downward direction. Control plot was located at a distance of 2000m approximately 2km – North West of the flare downwind direction, as contained in Table 2.2

Table 2.2: Layout of the experimental plots- Land preparation and planting

0 – 150m	150 – 300m	300 – 450m	450 – 600m	1000 – 2000m
NR – 8082	NR – 8082	NR – 8082	NR – 8082	NR – 8082
TMS– 30572	TMS – 30572	TMS – 30572	TMS – 30572	TMS–30572
NR – 84292	NR – 84292	NR – 84292	NR – 84292	NR – 84292

Stem cuttings 24cm-30cm length with 4-5 nodes, inserted in the mounds at an angle of 45^0. 90 – 100cm was the distance a part. Weeding was done 3 –4 weeks after planting and subsequently to keep off rodents and competition, until canopy was formed[12] and[13]

3.4 Measurement of Radiation

Thermal radiation:

Heat radiation was measured with a pyranometer(Serial No: SOL 5256 100224922) equipped with an automatic logging system. The sensor was focused towards the direction of flare for Ten minutes interval to record radiation every ten seconds interval. The mean reading taken over the ten minutes for a period of 1hr (one hour) exposure time was then recorded as the thermal radiation value at 0-150 m and this was done for the 2 km farm layout.

Data collection and physical analysis:

The following parameters were measured monthly.

(i) Leaf area:

The area of the leaf was measured according to the method of Iyagbaet.al.[14].In these methods cassava leaf was traced on a flip chart sheet. The traced paper area was cut out. A square area was measured on another flip chart paper and the area of the square calculated and recorded. The weight of the square sheet was also recorded. Also, the weight of the traced area of the leaf was recorded using an electronic weighing balance Model: Shimadzu Electronic Analytical balance from Oando Marketing Laboratory.

The area of the leaf was calculated using simple proportion comparable with the known weight of the square sheet and expressed as a conversion factor (C.F).

Weight of square sheet – 5.900g

Calculated area of the square sheet – 900cm^2

CF = $900cm^2 \div 5.900g$ = 152.542cm^{2}g^{-1}

(ii) Length of petiole and plant height:

The length of petiole was measured using a transparent meter rule, while the height of plant was measured using a rope, which was then measured on a meter rule.

(iii) Diameter of stem and petiole:

The main stem and Petiole diameters were measured by means of venier calipers. The stem and Petiole were measured at ground, middle and top levels and the mean calculated.

(iv) Number of leaves:

The number of leaves was estimated by counting the leaves on the main vine.

(v) Disease index:

The severity of leaf infestations (leaf spot, leaf blight, Cassava Mosaic) was assessed using the methods of Maduewesi[15]in which arbitrary scale ranging from zero to 5 were chosen, and using physical observation such as colour, shape etc.

0 – No disease
1 – Trace
2 – Mild
3 – Moderate
4 – Severe
5 – Very severe

(vii)Tuber number and weight per stand:

The number of tuber per stand was estimated by physical counting of the tubers, while tuber weight per stand was measured using the processing weighing balance. (Lever Balance) and the mean value from three stands (mounds) per cultivar recorded.

Data Analysis:

The statistical differences were analysed by analysis of variance and least significant difference as described by Wahua,[20].using mean of three determinations Also, descriptive analysis and two-way analysis of variance (ANOVA) were performed to determine the general trend of experimental data. Mean separation was performed on the analysed data using Duncan's multiple test with the aid of SAS version 9.1 software (SAS 2003)[16]

III. Results And Discussion

The results of relationship between thermal radiation and physical properties of cassava cultivars grown at various flare distance are shown in Table 3.1.

The results of the effect of seasonal variation on physical properties of some cassava cultivars are shown in Table 3.2.

Figure 1.0**: Effect of flare distance and seasonal variations on the leaf area (cm^2) of cassava grown around gas flare site**

Figure 2.0: **Effect of flare distance and seasonal variations on the disease index of cassava plant grown around gas flare site**

Table 3.1: Relationship between thermal radiation (E) and physical properties of cassava cultivars grown at various flare distance

			Physical properties						
Flare distance (M)	**Cultivars**	**Thermal Radiation (w/m2) Mean ± SEM**	**Leaf area (cm^2)**	**Plant height (cm)**	**No. of leaves**	**Length of petiole (cm)**	**Diameter of petiole (cm)**	**Diameter of stem (cm)**	**Disease index**
0-150	NR-8082	603.84±5.76a	0.792**	-0.725**	0.812**	0.792**	0.441**	0.211	-0.045
	NR-84292	603.84±5.76a	0.683**	-0.899**	0.856**	0.881**	0.114	-0.475**	-0.402*
	TMS-30572	603.84±5.76a	0.432*	-0.880**	0.676**	0.699**	0.548**	-0.184	-0.601**
150-300	NR-8082	588.40±4.0b	0.075	0.483**	-0.117	-0.048	0.108	0.503**	0.503**
	NR-84292	588.40±4.0b	0.582**	0.115	0.541**	0.479**	0.025	0.041	0.316
	TMS-30572	588.40±4.0b	0.227	0.433**	0.419*	0.320	-0.111	0.226	0.399*
300-450	NR-8082	557.29±1.49c	-0.704**	0.759**	-0.239	-0.851**	-0.643**	0.595**	0.332*
	NR-84292	557.29±1.49c	-0.469**	0.727**	0.168	-0.524**	-0.497**	0.503**	0.169
	TMS-30572	557.29±1.49c	-0.575**	0.763**	0.094	-0.290	-0.582**	0.485**	0.395*
450-600	NR-8082	448.91±5.37d	-0.542**	0.129	-0.598**	-0.438**	-0.385**	0.375*	-0.572**
	NR-84292	448.91±5.37d	-0.549**	0.561**	-0.553**	-0.509**	-0.532**	0.429**	-0.049
	TMS-30572	448.91±5.37d	-0.542**	0.559**	-0.659**	-0.649**	-0.175	0.566**	-0.106
1000-2000	NR-8082	428.83±0.79e	0.132	-0.493**	0.208	0.028	-0.077	0.244	-0.528**
	NR-84292	428.83±0.79e	-0.080	-0.459**	-0.503**	-0.091	-0.031	-0.186	-0.226
	TMS-30572	428.83±0.79e	0.141	-0.390*	-0.485*	-0.128	0.230	-0.072	-0.241

* = Correlation is significant at P<0.05; ** = Correlation is significant at P<0.0. Mean of 3 determinants

***Table 3.2*:** Effect of seasonal variationon the physical properties of some cassava cultivars

Cultivars	**Season**	**Leaf area (cm^2) Mean ± SEM**	**Plant height (cm) Mean ± SEM**	**Number of leaves Mean ± SEM**	**Length of petiole (cm) Mean ± SEM**	**Diameter of petiole (cm) Mean ± SEM**	**Diameter of stem (cm) Mean ± SEM**	**Disease index Mean ± SEM**
NR – 8082	Early Dry	199.06 ± 9.99^{abc}	189.009 ± 7.76^{c}	28 ± 2.0^{bc}	22.72 ± 1.04^{b}	0.361 ± 0.015^{ab}	2.416 ± 0.061^{bcd}	2.7 ± 0.2^{ab}
	Early Wet	55.17 ± 4.83^{f}	92.24±7.13^{d}	16 ± 1.0^{d}	11.96 ± 0.71^{c}	0.275 ± 0.011^{bcd}	2.278 ± 0.113^{ab}	1.7 ± 0.2^{bcde}
	Late Dry	70.59 ± 4.61^{f}	216.19 ± 6.09^{abc}	17 ± 2.0^{d}	10.49 ± 0.59 ^{c}	0.217 ± 0.011^{ed}	2.377 ± 0.064^{bcd}	3.1 ± 0.12^{a}
	Late Wet	239.04 ± 18.21^{a}	22177 ± 4.70^{bc}	27 ± 1.0^{c}	22.44 ± 1.06^{b}	0.322 ± 0.020^{abc}	1.507 ± 0.069^{e}	1.2 ± 0.2^{def}
NR – 84292	Early Dry	183.54 ± 10.00^{bcd}	185.77 ± 7.85^{c}	35 ± 2.0^{ab}	22.33 ± 0.88^{b}	0.262 ± 0.075^{cd}	2.098 ± 0.086^{cd}	1.5 ± 0.2^{cdef}
	Early Wet	117.95 ± 6.71^{e}	70.59 ± 6.43^{d}	23 ± 2.0^{cd}	13.44 ± 0.62^{c}	0.286 ± 0.021^{bcd}	2.442 ± 0.098^{bc}	0.9 ± 0.2^{ef}
	Late Dry	121.17 ± 5.05^{e}	233.25 ± 6.83^{ab}	26 ± 2.0 ^{c}	13.14 ± 0.62^{c}	0.168 ± 0.009^{e}	2.019 ± 0.073^{d}	2.1 ± 0.3^{bcd}
	Late Wet	192.59 ± 14.17^{abc}	241.61 ± 5.90^{ab}	23 ± 2.0^{cd}	20.03 ± 0.90^{b}	0.291 ± 0.021^{bcd}	0.971 ± 0.042^{f}	0.7 ± 0.2^{ef}
TMS- 30572	Early Dry	219.63 ± 6.93^{ab}	193.00 ± 6.97^{c}	41 ± 2.0^{a}	27.98 ± 0.78^{a}	0.391 ± 0.018^{a}	2.420 ± 0.059^{bcd}	1.6 ± 0.2^{def}
	Early Wet	140.59 ± 6.63^{de}	81.90 ± 5.14^{d}	22 ± 1.0^{bc}	13.77 ± 0.54^{c}	0.312 ± 0.021^{abc}	3.073 ± 0.133^{a}	1.2 ± 0.2^{def}
	Late Dry	153.73 ± 3.33^{cde}	231.63 ± 6.71^{ab}	29 ± 2.0^{bc}	19.67 ± 0.71^{b}	0.262 ± 0.010^{cd}	2.279 ± 0.064^{cd}	2.5 ± 0.3^{abc}
	Late Wet	218.16 ± 14.03^{ab}	246.85 ± 6.16^{a}	28 ± 1.0^{bc}	23.65 ± 0.79^{b}	0.359 ± 0.006^{ab}	1.305 ± 0.051^{ef}	0.7 ± 0.2^{ef}

Within column, Mean ± SEM with different superscripts are significantly different at the P<0.05

Mean of 3 determin

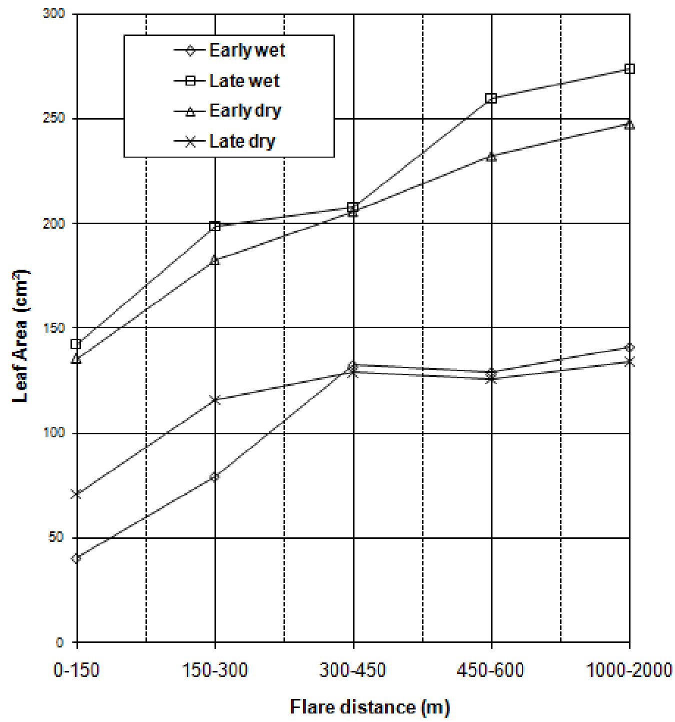

Fig.1.0 : Effect of flare distance and seasonal variations on the leaf area (cm2) of cassava grown around gas flare site

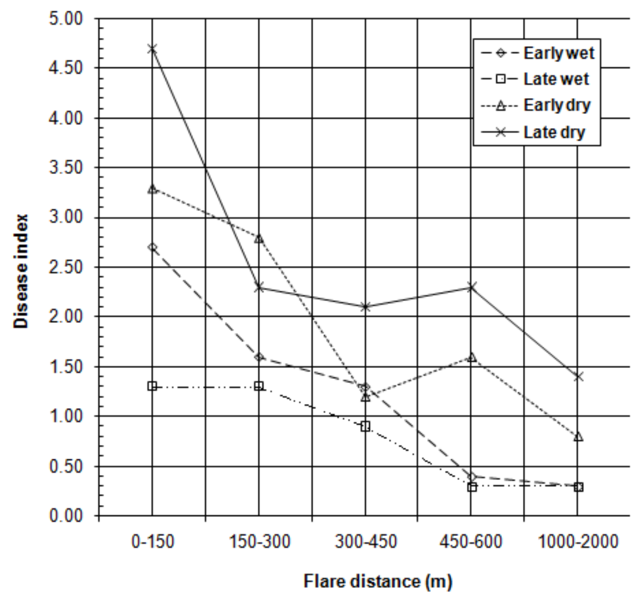

Fig.2.0: **Effect of flare distance and seasonal variations on the disease index of cassava plant grown around gas flare site**

Table 3.1 showed the relationship between thermal radiation (E) and physical properties of cassava cultivar grown at various flare distances. The correlation showed that at 0-0-150m (603.84±5.76aw/m^2,) leaf area was significant and ranged from (0.79to0.43), while at 300-600m(448.91±5.37d w/m^2,), leaf area ranges from (-0.47to-0.7). at1000-2000m (428.83±0.79ew/m^2)there was no significant relationship for leaf area (0.132 to-0.080).

The relationship was significant for other physical properties within (0-600m) flare distance. No significant relationship at 1000-2000m for diameter of stem, length and diameter of petiole and disease

The effects of seasonal variation on the physical properties of selected cassava cultivars are shown in Table 3.2. The leaf area (cm^2) of NR-8082 during late wet season ranked highest (239.04 ± 18.21cm^2) and the least value was 55.17 ± 4.83 cm^2 at early wet when compared with others. The values for late dry and early dry were 70.59 ± 4.61 cm^2 and 199.06 ± 9.99 cm^2 respectively

The effect of seasonal variation was significant in leaf area. The plant height was highest (246.85 ± 6.16cm) at late wet for TMS-30572 and late dry was 231.63 ± 6.71cm for NR-84292, 241.61 ± 5.90cm was recorded for late wet and early wet 70.59 ± 6.43cm, NR-8082, early wet 92.24. ±7.13 cm and late dry (221.77 ±4.70 cm). The effect of seasonal variation on plant height was significant (P<0.001). The number of leaves for NR-8082 ranged from 16 ± 1.0 (Early wet to 28 ± 2.0 early dry), NR-84292, had 23 ± 2.0 to 35 ± 2.0 for early wet and early dry respectively. TMS-30572 recorded the highest number of leaves (41 ± 2.0) at early dry and least number (22 ± 1.0) at early wet. Seasonal effect was significant in the number of leaves. The value of length of petiole for TMS-30572 ranged from 13.77 ± 0.54cm to 27.98 ± 0.78cm for early dry and early wet. For NR-8082 (10.49 ± 0.59 to 22.72 ± 1.09cm) (late dry and early dry) The length of petiole for NR-84292; ranged from 13.19 ± 0.62cm to 22.33 ± 0.88cm for late dry and early dry season. For other properties such as diameter of petiole and stem, the effect was significant with TMS-30572 at early dry and early wet was highest (0.39 ± 0.018) and (3.072 ± 0.133) for diameter of petiole and stem respectively. The disease was severe (DI=3.1 ± 0.2) at late dry season with NR-8082 and less with NR-84292 and TMS-30572 (DI=0.7 ± 0.2) at late wet season the effect was significant (P<0.001)

The effect of seasonal changes on the physical properties of three (3) cassava cultivars was presented in Table 3.2.TMS-30572 showed a high degree of tolerance to thermal heat, especially during the early wet with the leaf area value of (140.59 ± 6.63cm^2 and 219.63 ± 6.93cm^2) for early dry period. Also, during the period of highest thermal radiation the leaf area recorded was 153.73 ± 3.33cm^2 during the late dry season. This was closely followed by NR-84292, with NR-8082 showing the least tolerance to seasonal variation. Early wet, leaf area was 53.17 ± 4.83cm^2 and late dry 70.59 ± 4.61cm^2, although the highest leaf area was recorded by NR-8082 (239.04cm^2) during the late wet season, as presented in Table 3.2This work agrees with the work of Appadurai[17], that the growth rate increased with increasing leaf area and decline as the environmental factors no longer favours growth pattern. Accordingly the effect of season on leaf area was significant and this agrees with the work of Isichei and Sanford [18]that the leaf surface area exposed to the sun has been found to be proportional to the plant's productivity and yield. Plant height was highest during late wet season (246.85± 6.16cm) for TMS-30572, while NR-84292 had (241.61± 5.90cm) and NR-8082 had (221.77 ± 4.70cm) at wet season (Table 4.08). NR-84292 had the highest plant height (233.25±6.83cm) in late dry season closely followed by TMS-30572 (231.63± 6.71cm) and NR-8082 with the least height (216.19±6.09). On a visual observation, NR-8082 generally had more spread branches that were short, thus the plant heights showed the various response level of each cultivar to seasonal variations. These findings are in agreement with the work of Williams and Biddiscombe[19] who reported that plant height is a measure of planting performance, which is ideal for measuring response to temperature. The analysis of variance showed that the effect of seasonal variation on plant height was significant (P<0.001). Table 3.2 showed that the number of leaves increased over the various seasons and declined at the extreme weather condition during the late dry season.

TMS-30572 gave the highest number of leaves (41± 2.0) at early dry season and dropped to (29± 2.0) at late dry season, showing 29.3% decline in leaf numbers. The growth pattern revealed (66%) increased from early wet to early dry, during planting season. NR-84292 had increase (52.2%) in number of leaves from early wet growing season to early dry, while the decline was (26%). NR-8082 showed 100% increase in leaf numbers from early wet to early dry season, and thus the decline (54.5%) in number of leaves from early dry season to late dry was reported. From the above, TMS-30572 and NR- 8082 tend to show tolerance to seasonal variations, while NR-8082 appeared to shade most leaves during the late dry season (period of heavy drought and high temperature). Thus, Pirone[20]reported that during stress condition, Ethylene gas, which is stimulated by drought or other stress conditions, causes a separation layer to form at the base of the leaves. This is a defence mechanism of the plants, which shades some leaf tissue in order to preserve the life of the entire plant as in NR-8082. Pirone[20] further reported that stress conditions would result in cladoptosis that is the dropping of leaves.

In considering other physiological parameters, the length of petiole also responded to seasonal variation. Petiole lengths increased from the late wet planting season to early and late dry season and declined to produce shot petioles during the harsh late dry season.

During this study, TMS-30572 gave the highest petiole length (27.98 ± 0.78cm) at early dry and the late dry season recorded (19.67 ± 0.71cm) showing 29.7% decline. This was closely followed by NR-84292 with (40.1%) a decline in petiole length. Also, NR-8082 having (53.8%) reduction in petiole length during the late dry season, showing a marked tolerance by TMS-30572 and NR-8082 cultivars during stress condition. Generally, the petiole length of NR-8082 appeared shot and bearing small leaf area. These tolerance levels could be responsible for high yield of the cultivars. The effect of seasonal variation on diameter of stem and petiole was significant with TMS-30572 having the highest stem and petiole diameter, while NR-84292 had the least value.The disease index was severe (DI=3.1 ± 0.2) at late dry season with NR-8082, and less with NR-84292 and TMS-30572 respectively. TMS-30572 and NR-84292 showed tolerance to disease during the harsh seasonal variation. Most of the leaves of NR-8082 cultivar were coiled and twisted, which was in agreement with the work of Okezie and Okeke, [21.]

At 0-150m, figure 1.0 showed that the combined effect of thermal radiation and seasonal variation was evident in leaf area during the early wet and late dry season. This accounted for 25.42% increase from late wet to early dry, while the decline was 47.7% from early dry to late dry period of growth. However, this trend improves as the distance from the flare (reduced thermal effect) increases. At 1000-2000m, the control point, leaf area during the growth phase showed 47.9% growth rate during the late wet over crops grown at the 0-150m, early dry was 45.5.9%, late dry 47.6% and 71.6%, during early wet season over crops cultivated at 0-150m flaring distance.

In Figure 2.0 the disease index of 4.7 and 3.3, were recorded during late dry season and early dry season at 0-150m, while the least value for disease index 0.3 was recorded for control distance during, late wet and early wet season respectively. Figure 2.0 showed a trend with severe disease infestation during late dry season. Leaves of cassava crops at 0-150m appear chlorotic. Ochili, [22] reported that white flies transmit mosaic diseases of the leaves and cause white patches and molting of the leaves with characteristic mosaic patterns. Early development of leaf chlorotic areas can be observed and leaflet are distorted. In the susceptible cultivar (NR-8082) the leaves are reduced in size, misshapen, and twisted giving a leaf-curl appearance.

IV. Conclusion

The effect of high thermal energy from the flare is pronounced on plant. In places where gas is flared, grasses and trees do not grow well within large radius. Owing to the high temperature of the immediate environment of the flare, cassava planted does not do well.

This study revealed that Gas flare (thermal stress) causes some physiological changes in the cassava plant ranging from internodes shortening of apical internodes, leaf distortion and discoloration, crinkling and pebbling, reduction in leaf size.

The study further demonstrated that NR-8082 and TMS-30572 had a high degree of tolerance to heat and other environmental stresses, with NR-84292 showing 50% plant population losses at 0-150m flare distance with thermal radiation value of ($603.84 w/m^2$),

This work provides an escort into allaying the fears of the rural farmers over the effect of gas flaring on the quality of cassava grown around gas installation and flare sites.

It is therefore recommended that further investigation into cassava tolerance potentials should be carried out by introducing more cultivars grown around gas flare sites.

Oil companies and government regulatory agencies should embark on more people's parliament (Public fora) in areas of operation in the Niger Delta to disseminate information on the zero yields of crops grown around 0-150m flare zone.

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